Demonstrated Cases of Insecurity in Control systems

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Report Documentation Page

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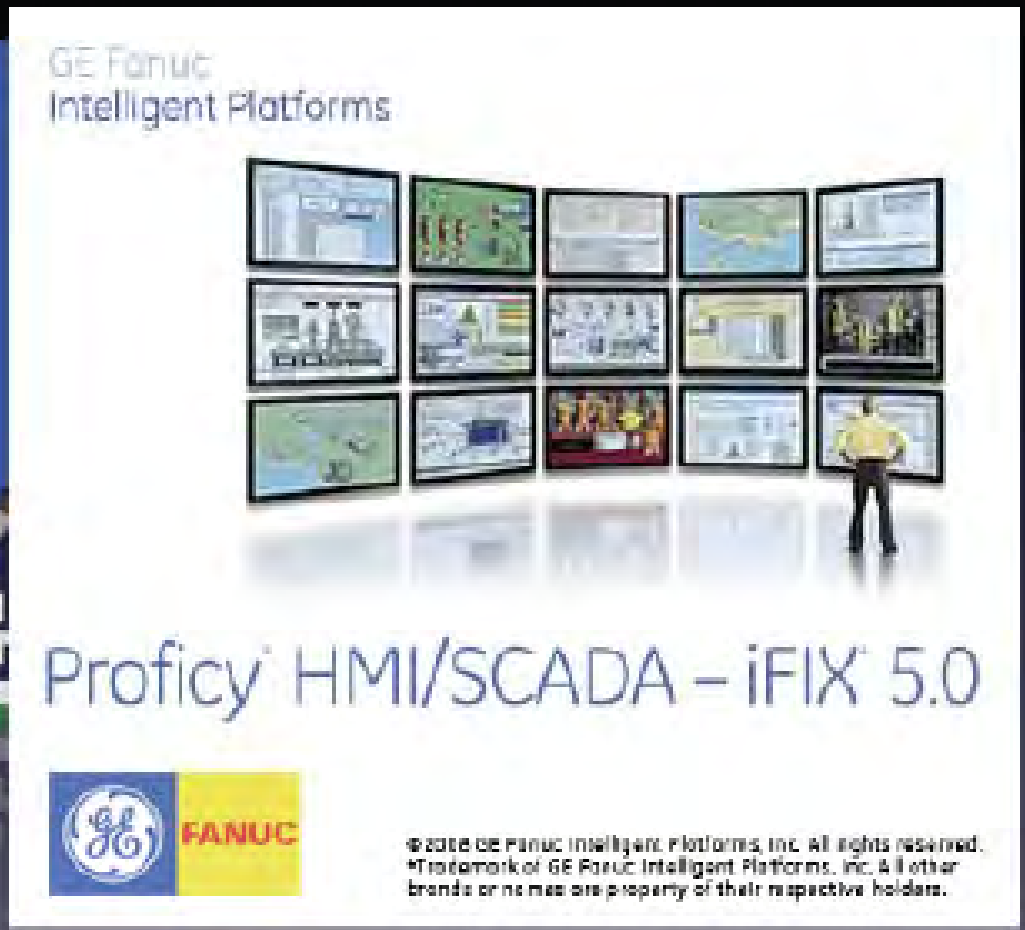
Vulnerabilities in HMI Software

- GE Fanuc Proficy iFIX 4.5/5.0
- Insecure storage of passwords
- Authentication bypass
- Allows those with access to escalate privileges on the SCADA system
  - Lower-level personnel with physical access
  - Remote attackers with access via other/mainstream exploits

Case Study: iFIX



US Cert Vulnerability Announcement #310355
http://www.nerc.com/fileUploads/File/Events%20Analysis/A-2009-02-10-01.pdf

Insecure Password Storage

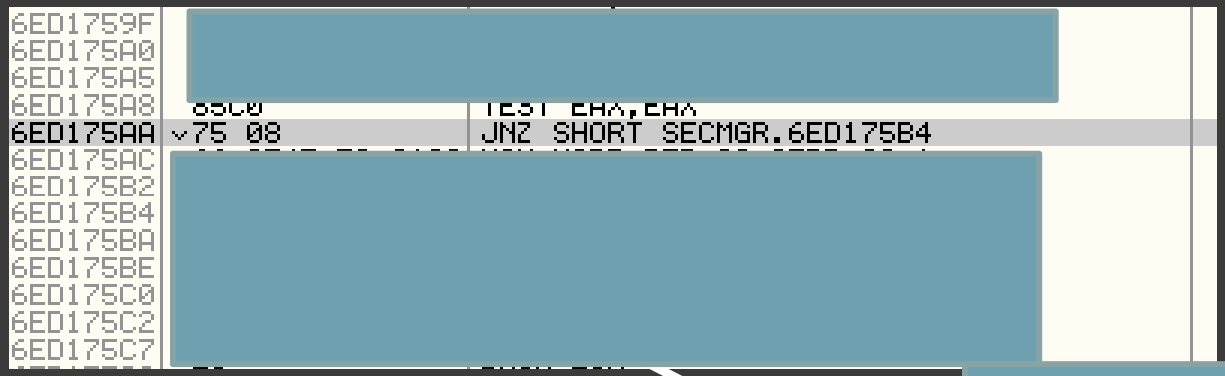
```
0000000: 2cd1 2df9 4763 087f 86d1 d4f8 45d6 0990  ,.-.Gc......E...
0000010: 41d8 dfba fbe0 a235 088e 0ab3 6f63 3c18  A......5....oc<.
0000020: 812e d881 b908 7d4b 7ab9 33cd e1de 9a15  ......}Kz.3.....
0000030: f4d0 2c30 621c f857 6019 dea3 4a11 f6fd  ..,0b..W`...J...
0000040: 7d28 05e2 cc4f 772c 8977 a92b 4cca 4677  }(...Ow,.w.+L.Fw
0000050: 9353 fec4 bd81 793a 9ac3 5b35 e604 e26d  .S....y:..[5...m
0000060: 5542 10ea 8b0d 5228 a408 2974 9da2 d3a3  UB....R(..)t....
0000070: 28a4 7c59 04ed dbc6 6fee 8c9f cdb1 65ef  (.|Y....o.....e.
```

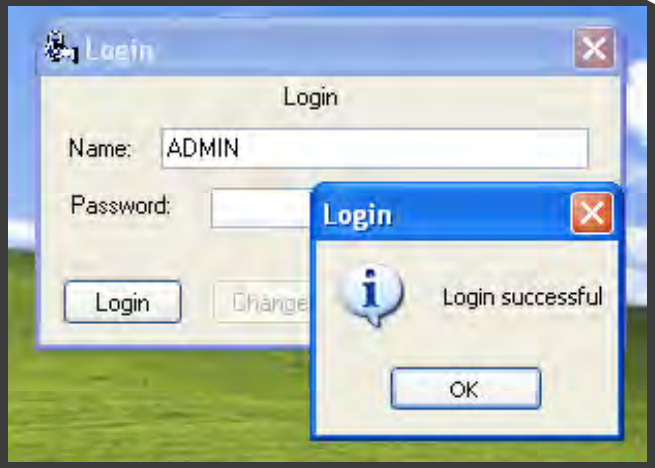
User's Full Name
Password
Username

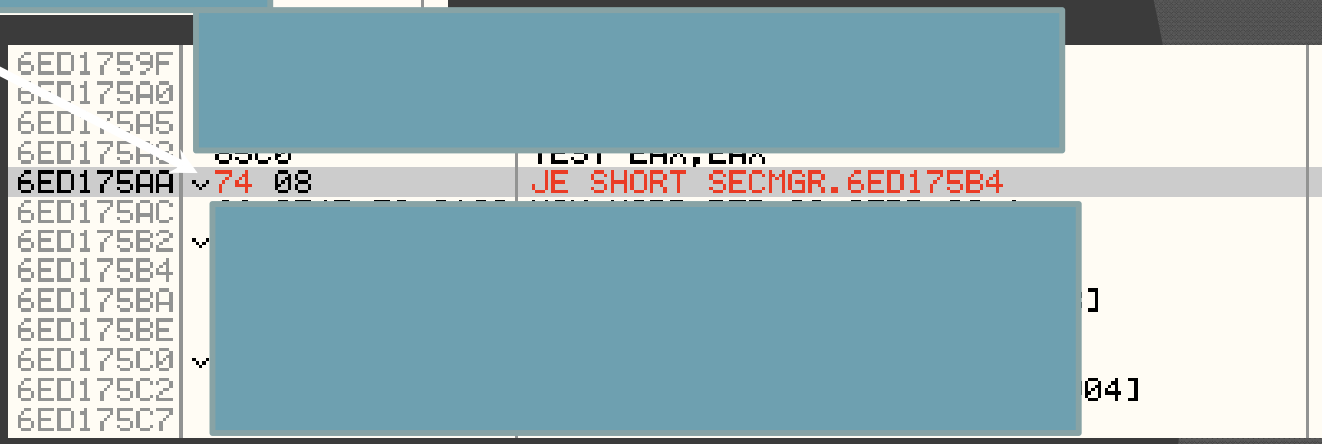
```
bash-3.2$ ./ifixpassdump.py XTCOMPAT.UTL
User     Password                 Full Name
-----------------------------------------------
ADMIN    ADMINADMIN888            SYSTEM ADMINISTRATOR
GCLARK   GC                       GEORGE CLARK?5??
GUEST    GUEST                    GUEST ADMINISTRATOR
LJONES   MYPASS                   LAURA JONES?5??
PSMITH   PSMITH1978               PETER SMITHA?5??
TWHITE   JI74ERT                  THOMAS WHITE?5??
```

- User information/password is XOR'd with a static key and saved to XTCOMPAT.UTL
- User credentials can be recovered from this file

Authentication Bypass

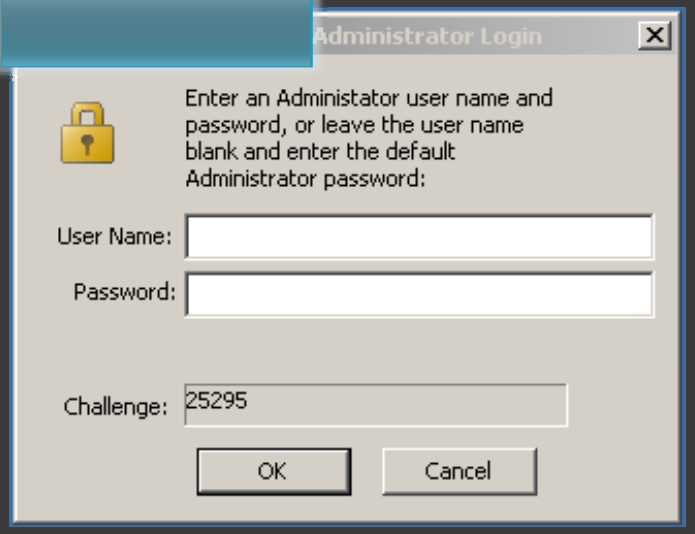


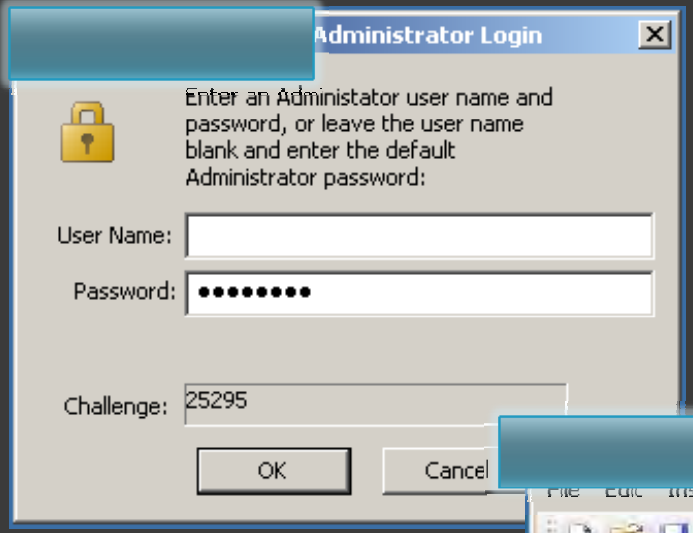


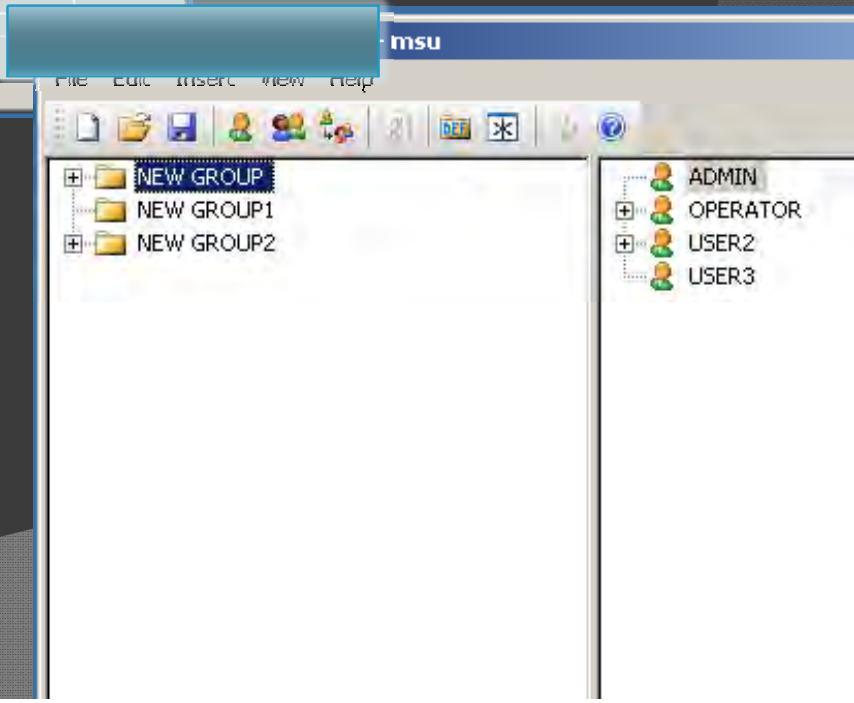


- Authentication is performed by a process running as the current Windows user
- A copy of the login program and security DLL can be made, modified, and used to log in as any user with any incorrect password
  - Single-byte patch to the DLL to branch differently after comparing passwords

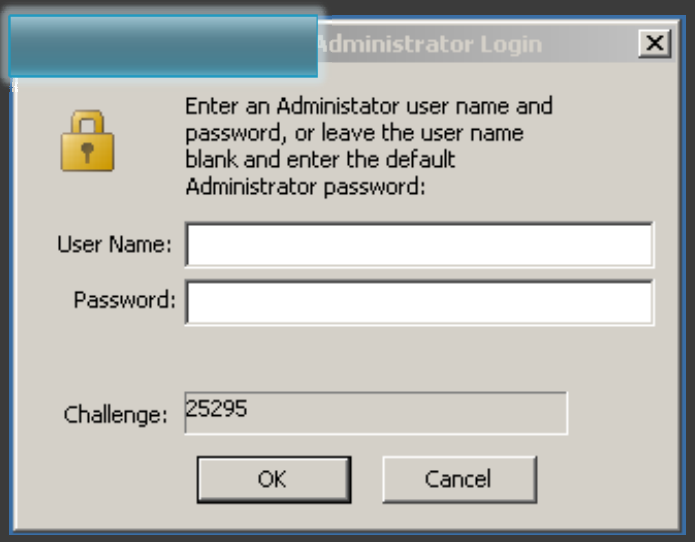
More violations of security principles in HMI software…



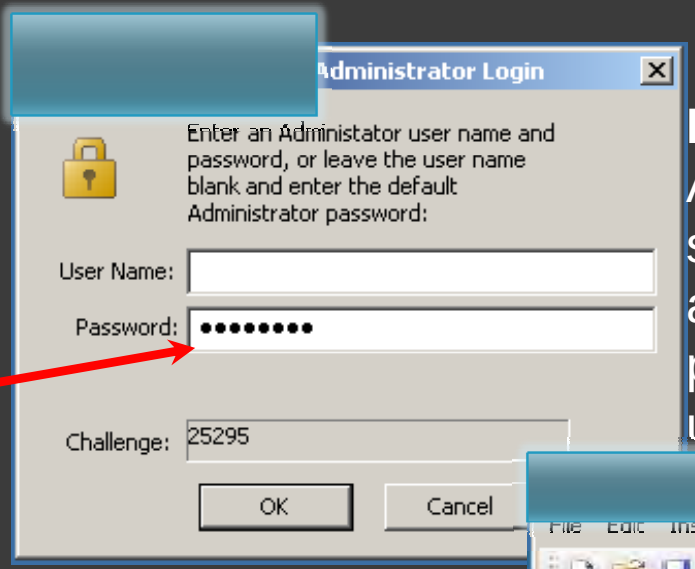




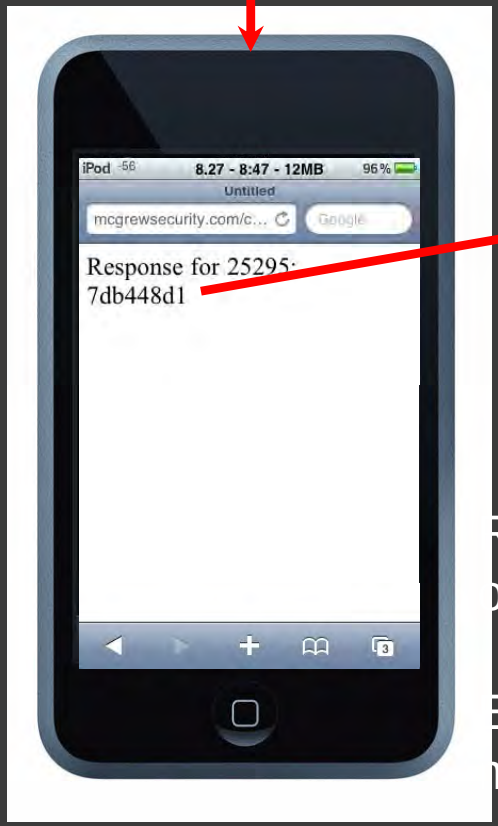
Locked-out customers may call support to get a response to the “Challenge” Field



An attacker can discover (on their own time/systems) the algorithm used for challenge responses

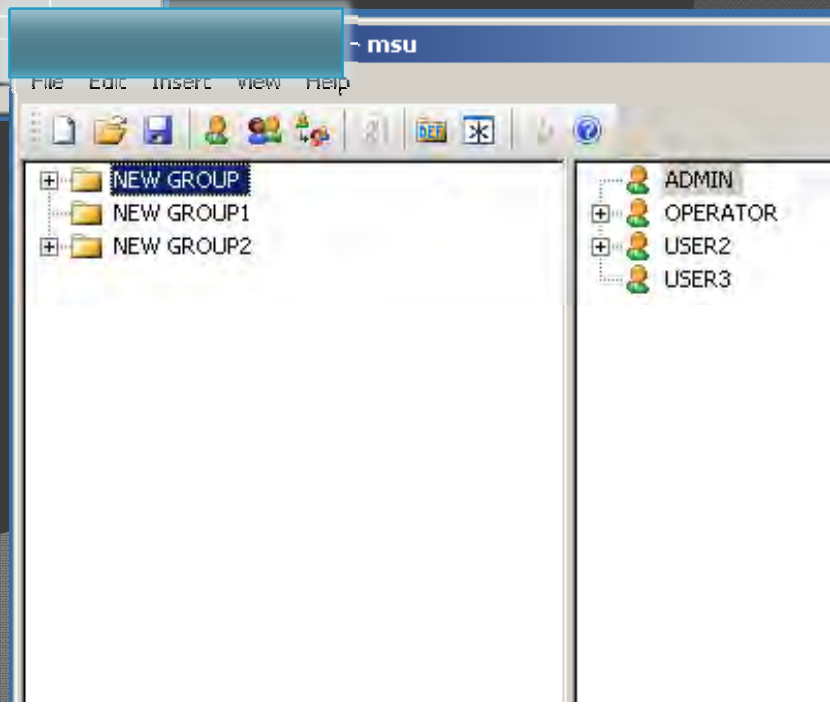


Result:
Attacker is logged into security server as the default admin account. Can grant/deny permissions, add/remove users



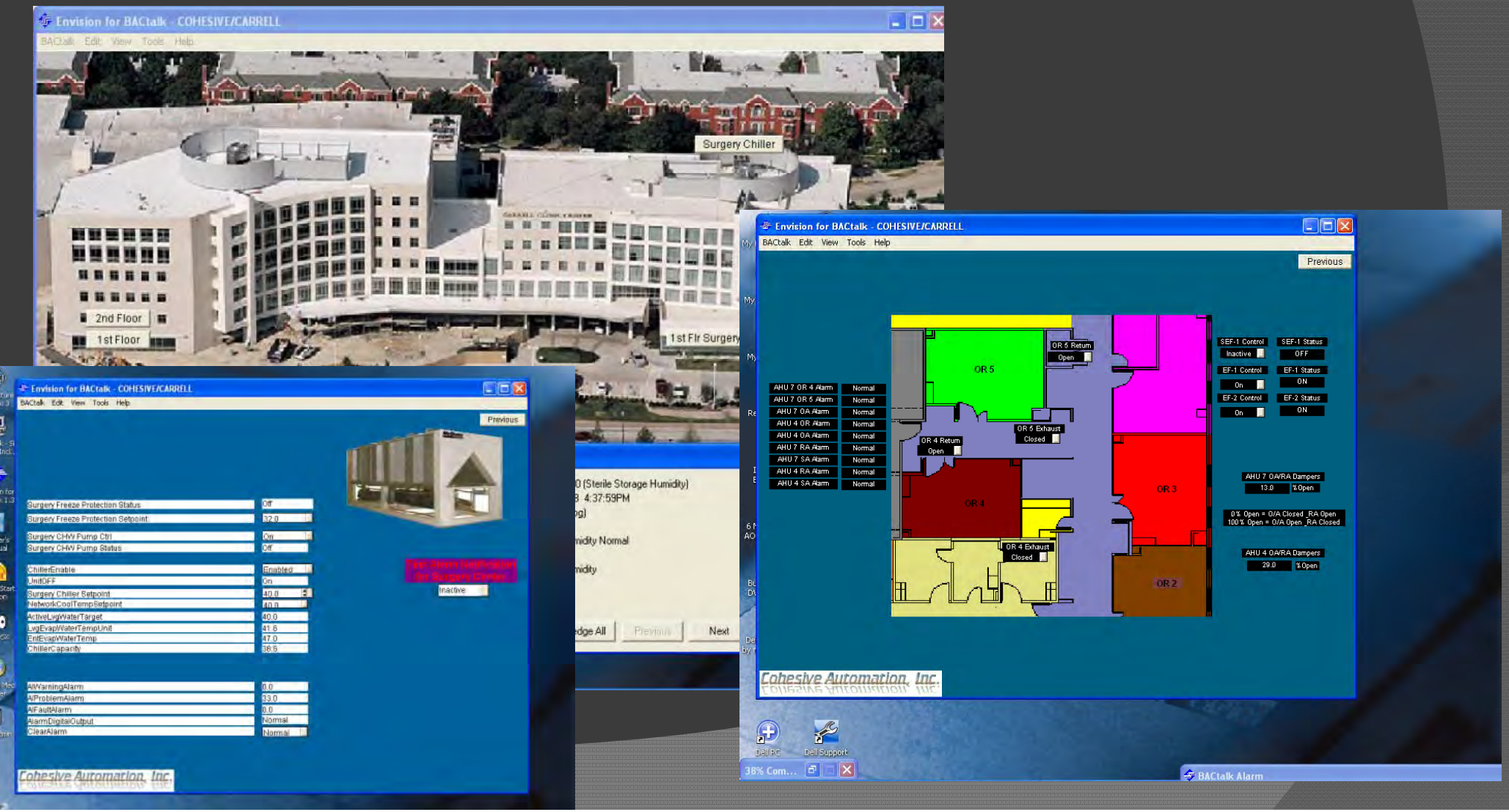
Response is first 8 characters of MD4(challenge)

Easily calculated on a mobile device



Real-World HMI Security Incident

Texas Hospital Control System Incident – late June to early July 2009



SCADA Communications Vulnerabilities

- PLC Radios
  - Freewave 900 MHz
    - 902-928 ISM Unlicensed band
    - Point to Multi-Point serial over wireless
- Attacks
  - Scanning for radios
    - NMAP-like capability for PLC radios
  - Eavesdropping
  - Denial of Service

Student Researcher: Bradley Reaves

Discovery Scans

- Determines:
  - Existence of network
  - Access Control (Network Identifier or Serial Number)
- Network Identifier Scan
  - 12,288 combinations
  - Scan time: 6.4 secs/combo
  - Max runtime: 21.76 hours

Discovery Scans

- Serial Number Scan
  - 96,000 Combinations
  - Scan Time: 1.7 secs/combo
  - Max runtime: 45.5 hours

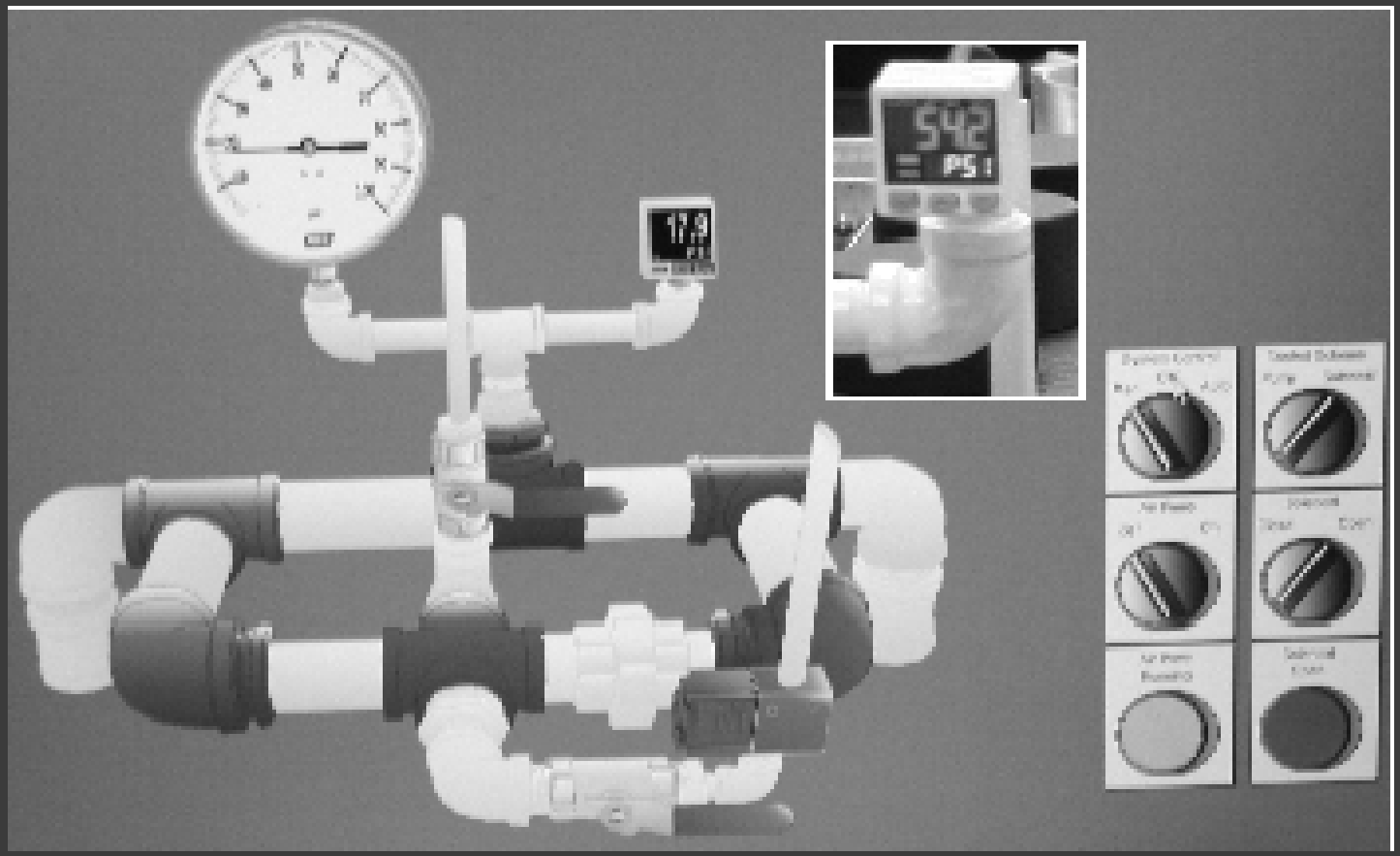
Infiltration Scans

- Seeking a continuous, unbroken connection
- Need Frequency Settings
- 539,400 Legal Combinations
- Can scan at 12s / combination
- Max time:75 days
- +2.25 days to eliminate false positives

Denial of Service

- If our rogue slave transmits continuously, nothing else gets through.
  - cat /dev/urandom > /dev/ttyS0 brings the whole system down
- This can be **deadly** in a PCS system
- This attack mirrors symptoms seen in the Bellingham incident

Denial of Service



Conclusions

- We (our lab, vendors, and infrastructure) have made significant progress in SCADA security.
  - Lots of vulnerabilities
  - Potential for serious incidents
  - Lack of applied security principles
- We are heading in the right direction
  - Finding vulnerabilities
  - Averted at least one control system incident
  - Mapping out where these principles can be applied, and educating others